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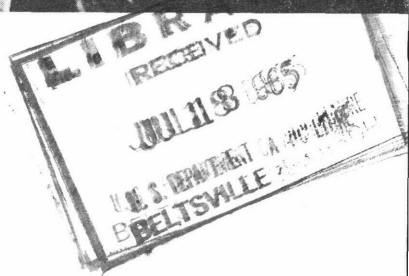
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GROWING SAFFLOWER

An Oilseed
Crop

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Washington, D.C.

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GROWING SAFFLOWER—

An Oilseed Crop

Prepared by
Crops Research Division
Agricultural Research Service

Safflower¹ is an oilseed crop adapted to the wheat and barley areas of the western United States that have dry atmosphere in the latter part of the growing season.

The crop has been known for centuries in India, the Middle East, and North Africa, where it is the source of a dye and an edible oil. Safflower was introduced experimentally as an oil crop in the United States in 1925. American farmers began growing safflower near the end of World War II.

About 320,000 acres of safflower were planted in the United States in 1965.

The seed of commercial varieties contains 32 to 40 percent of oil. Varieties with increased oil content are being developed.

USES

Safflower oil is light colored and easily clarified. Oil consumed in the United States is used as salad

and cooking oil, in the manufacture of margarine, and as a drying oil in paints and varnishes.

Meal or seedcake made from safflower seed is a protein feed supplement for cattle, sheep, and poultry. Meal from unhulled seed contains 18 to 24 percent of protein; meal from hulled seed, 28 to 50 percent of protein.

DESCRIPTION

Safflower is an annual of the thistle family. Commercial varieties grown in the United States are spiny.

The plant has composite flower heads with green bracts. The most common varieties have yellow or orange flowers; some varieties have red or white flowers. Each plant usually produces 1 to 5 flower heads; each head develops 15 to 50 seeds.

Safflower develops sturdy taproots. It forms oblong, waxy leaves and grows slowly during periods of cool, short days in the early

¹ *Carthamus tinctorius* L.

part of the season. Branching begins from the central stem when the plant is 8 to 15 inches high. Safflower reaches its full height of 1½ to 5 feet when it flowers.

Safflower matures in 110 to 150 days as a spring-planted crop and in 200 or more days as a fall-planted crop. Most safflower is spring-planted.

Seed weighs 37 to 48 pounds per bushel; the weight depends on the variety and on growing conditions. The hull accounts for ⅓ to ½ of the total weight of the seed. The seed contains 32 to 40 percent of oil, 11 to 17 percent of protein, and 4 to 7 percent of moisture.

Safflower usually will not grow as a weed; competing wild plants overshadow it before it becomes established.

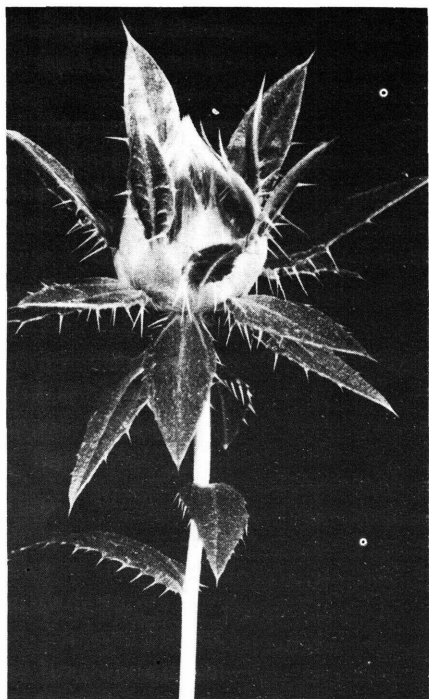
ADAPTATION

Safflower is adapted to parts of the northern Great Plains, the area between the Cascade and Rocky Mountains, the interior valleys of California, and irrigated sections of Arizona. At times, it has been grown successfully in parts of all States west of the 100th meridian.

In some parts of the Great Plains and in California, safflower has been grown under irrigation. In California, most of the safflower is grown without irrigation, either following an irrigated crop or on land with a high water table.

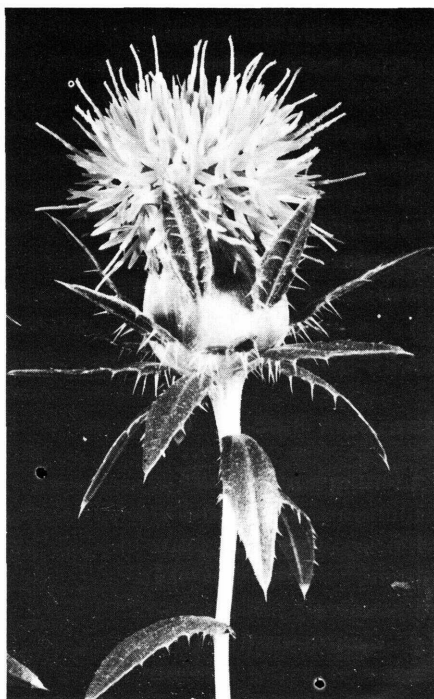
Weather

Emerging plants grow vegetatively in short days of spring.



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Flower head before opening.



BN-6698

Head in flower.

Longer days promote flower head formation.

Generally dry atmospheric conditions during and after flowering are necessary for proper seed set and high oil content.

Seedlings can withstand temperatures down to 20° F.; plants 4 to 5 inches tall tolerate temperatures down to 25°. Varieties differ greatly in tolerance to frost during early growth. Freezing temperatures may damage budding and flowering plants. Frost on an unripened crop may reduce the quality and yield of seed.

Safflower is more tolerant of wind and hail than are barley and small grains. The stems may be damaged severely by hail while they are actively growing and succulent.

Moisture

Safflower may be grown under irrigation or as a dryland crop. It also may be grown following a wetland crop—such as rice—on high-water-table land without additional irrigation.

Safflower needs soil moisture from the time it is planted through flowering. If it does not have enough moisture during budding, safflower may not produce a satisfactory yield.

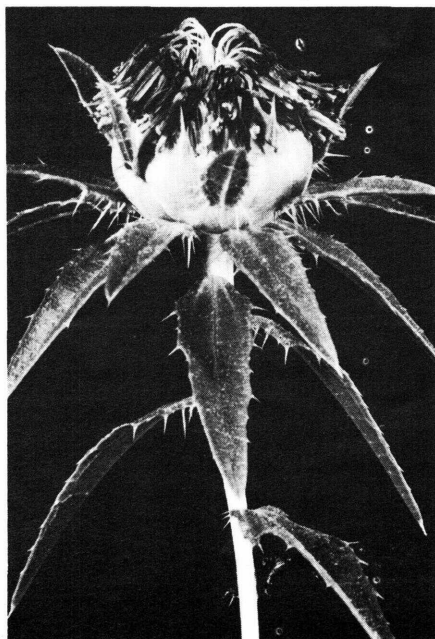
Frequent rains or periods of high humidity during ripening and harvesting may reduce seed yields.

Safflower grown under total irrigation needs 3 to 3½ acre-feet of water. Highest yields are obtained where subirrigation is possible or surface irrigation carefully controlled.

For maximum yields under dryland conditions a total of about 25 acre-inches of water will be required. In areas where rainfall is not well distributed during the growing season, safflower needs soil moisture to a depth of 4 feet at planting time. Satisfactory yields may be obtained in alternate crop-fallow systems if the equivalent of 16 to 18 acre-inches of soil moisture is available.

Soil

Safflower does best in soils neither extremely acid nor alkaline. It thrives in heavy clay soils with good water-holding capacity. It grows satisfactorily in deep sandy or clay loam soils with good drainage if soil moisture is adequate. When grown on irrigated land with poor water



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Head after flowering.

penetration, safflower is vulnerable to root rot diseases.

Place in Rotation

Safflower often replaces barley or other feed grains in rotation. It matures too late to be used in double cropping.

On dry land, highest safflower yields follow summer fallow. On irrigated land, safflower can follow wheat, corn, potatoes, beets, rice, grasses, clover and other legumes, or small grains. Safflower should not follow itself in the rotation—particularly on irrigated land—because of disease hazards.

Late crops—such as potatoes, beans, and corn—produce higher yields when planted following safflower than they do following small grains.

ECONOMIC FACTORS

Because safflower is a relatively new crop in the United States, the market is not fully developed here. Usually the crop is grown and sold under contract. Some processors guarantee growers a fixed price per ton; others pay the market price at harvest. Often the processor supplies seed.

Before deciding to plant safflower for the first time, discuss selling the crop with an established contractor, processor, experienced grower, or your county agricultural agent.

Cost of Growing

The cost of growing safflower may be compared with the cost of growing barley in the same area. Under irrigation, safflower requires

two additional irrigations and costs about \$10 more per acre to produce than barley. The costs of growing safflower and barley without irrigation are about equal.

Safflower is planted, cultivated, and harvested with the same machinery as small grains. Custom rates for harvesting safflower are slightly more than for harvesting barley.

Price

In recent years, the average price received by farmers for safflower seed was about twice that for barley.

Yields

Poor yield in the area of adaptation are usually caused by lack of adequate soil moisture. Poor yields also may be caused by poor land, improper seedbed preparation, weeds, late planting, early frost, diseases, and insects.

Under the best growing conditions, safflower yields about the same as barley.

Average yields in California are around 1,700 pounds of safflower seed per acre. Yields above 4,000 pounds of seed per acre are not uncommon. In contrast, some dry-land plantings in poor years are failures.

In the northern Great Plains, yields usually are in the range of 500 to 1,000 pounds of seed per acre. Crops on fallow land may yield as much as 2,000 pounds per acre.

VARIETIES

Safflower varieties differ in flower color, degree of spininess, diameter

of seed heads, oil content, resistance to disease, and ease of harvest.

Since 1946, many safflower varieties have been developed, introduced, and then replaced by superior varieties. A number of new varieties with increased oil content, less spininess, less hull, and greater resistance to disease, are being developed. Consult your county agricultural agent, the State agricultural experiment station, or commercial companies for latest information on recommended safflower varieties for your area.

SEED

Obtain safflower seed from a seed processor or wholesale seed distrib-

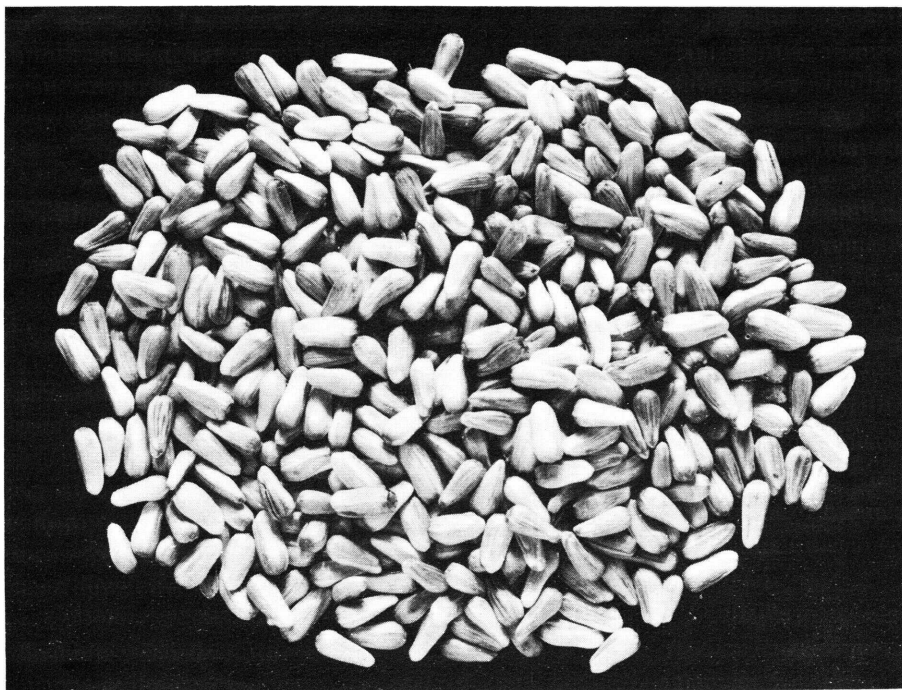
utor. Plant only seed that is free of foreign matter, weed seeds, and small grains.

Seed treatment helps control seed-borne rust and *Alternaria* and insures more uniform stands of vigorous plants. Where wireworms are a problem, treat safflower seed with a recommended insecticide before planting.

Ask your county agricultural agent for current seed treatment recommendations.

Most seed treatments are poisonous. Treated seed should be plainly tagged or labeled as follows:

Treated seed—Poisonous—Do not use for food, feed, or oil.



BN-6697

Safflower seed, natural size.

PLANTING DATES

Planting dates are determined by local conditions—including soil moisture, weeds in the seedbed, and temperatures.

If the top 4 inches of soil is dry, delay planting until after rain or an irrigation.

Plant safflower when soil temperature is about 40° F. or higher. Seeds germinate quickly at temperatures near 60°; plants may take 30 days to emerge at soil temperatures below 40°.

Plant safflower during early winter in Arizona, in irrigated valleys of southern California, and in other areas where winter temperatures remain above 20° F.

Do not plant safflower in the fall or winter on severely weed-infested land. Fall or winter planting, unlike spring planting, does not allow a good opportunity for weed control.

In the northern Great Plains, early spring planting produces highest yields—plant safflower as early as possible after frost is out of the ground and when temperatures below 20° F. are unlikely.

CULTURAL PRACTICES

Soil Preparation

For spring-planted safflower, a fall plowing is recommended where winter erosion is not a problem. Plow as soon as possible after harvesting the previous crop.

For spring- or fall-planted safflower, prepare a seedbed that is free of weed seeds of other crops. Break up large clods and work the

soil into a firm surface. Soil should be moist at least 1 inch below the surface.

Allow weed seeds, volunteer wheat, and other small grains to germinate. Immediately before planting safflower, destroy weeds and grain by using a plow, disk, duckfoot cultivator, rodweeder, or one-way disk plow. Till the soil to kill a second crop of weeds if possible.

Fertilizing

Where nitrogen increases other crop yields, it will probably benefit safflower. Nitrogen is not needed on most soils following alfalfa, sweet clover, or fallow.

Natural fertility of the land and available moisture determine the amount of nitrogen needed. The need varies from zero in certain parts of the Great Plains to as much as 120 pounds of nitrogen per acre in some areas of California.

Where safflower is grown under intensive irrigation, use 100 pounds of nitrogen per acre at planting time.

Phosphate is used in some areas.

Consult your county agricultural agent for fertilizer recommendations.

Planting

Safflower may be planted by solid drilling, in cultivated rows, or by broadcasting.

Solid drilling, which is used most often in dryland areas, produces heavy stands. Safflower usually is planted in cultivated rows when it is grown under irrigation or when weeds are a problem. Broadcast-

Recommended Planting Dates

REGION :

Planting dates

Arizona :

Safford-----	Nov. 1 to Jan. 15
Salt River Valley-----	Dec. 1 to Jan. 15
Yuma -----	Dec. 1 to Jan. 15

California :

Imperial Valley-----	Dec. 1 to Jan. 15
Southern San Joaquin Valley-----	Dec. 1 to Feb. 15
Sacramento and Northern San Joaquin Valleys.	Feb. 15 to Apr. 20

Nebraska, Idaho, Utah, Montana, North Dakota, South Dakota, and Washington. Apr. 10 to May 20

ing by air is used at times in California.

Safflower is usually planted with a grain drill. Seed runs through the drill faster than barley; set the drill as you would for 20 pounds of barley to plant 30 pounds of safflower per acre. Drills set for 3 pecks of wheat deliver about 30 pounds of safflower per acre.

Plant seed 1 to 2 inches deep into moisture for best results. Seedlings will emerge from a depth of 4 inches in moist soil if a crust does not form on the soil surface.

SOLID DRILLING.—Drill rows 6 to 14 inches apart for solid stands. Seeding rates vary from 15 to 40 pounds of seed per acre on dryland areas. On irrigated land and on land with a high water table, sow solid-drilled safflower at the rate of 25 to 60 pounds of seed per acre. Stands of 3 to 4 plants per square foot are best. If the stands are thinner, weeds may overshadow safflower. Stands may be slightly thicker on irrigated land without harm but in stands of 6 plants per

square foot on dry land overcrowding will reduce yields.

ROW PLANTING.—Plant cultivated rows at the rate of 8 to 20 pounds per acre for dryland areas and 20 to 25 pounds per acre for irrigated and high-water-table areas. A cultivated row should contain 5 to 12 plants per foot. Place rows 18 to 24 inches apart to allow for cultivation and irrigation. Plant furrow-irrigated safflower in rows 20 to 30 inches apart or on beds 40 inches from center to center with 2 rows set 14 inches apart on each bed.

BROADCASTING.—Broadcasting is not recommended for late planting when soil has begun to dry. Seed should be broadcast on moist soil. Use 30 to 60 pounds of seed per acre on irrigated land or 25 to 50 pounds of seed per acre on dry land. After seeding, harrow to cover safflower with 2 to 4 inches of soil.

Cultivation and Weed Control

During slow early growth, safflower may be crowded out by

weeds. Control weeds by crop rotation and by cultivation. Chemical weed killers have shown promise with safflower, but are not widely used because of the high cost. The crop can be severely damaged by 2,4-D, other hormone-type herbicides, and dinitro selectives. For the latest information and recommendations on chemical control of weeds in safflower, see your county agricultural agent.

Weeds may come up before safflower does if rainfall occurs soon after planting. Most small weeds in solid-drilled stands can be destroyed by shallow harrowing.

Work the field with a harrow, rotary hoe, or finger weeder diagonally or crosswise to the direction of seeded rows. Set teeth fairly straight and weight the harrow.

Harrow seedbeds for the first time before plants emerge, or when only a few seedlings have emerged. Do not harrow after complete emergence until plants are about 3 inches high; at this time harrowing may cover plants and reduce stands.

If weeds remain a problem, harrow again when plants are 3 to 6 inches high. At this stage, safflower begins rapid growth and competes well with small weeds in solid-drilled fields so that hoeing usually is not necessary.

Harrowing furrow-planted safflower before emergence is not recommended because it may bury seed too deep.

Cultivate row-planted safflower two or three times in the same manner as for other row crops. The final cultivation may be made just before flowering.

IRRIGATION

Irrigation will increase safflower yields when soil moisture is low. Soil moisture and temperature affect the number of irrigations needed. Two to five irrigations may be needed for maximum yields. Although plants need adequate moisture from planting through flowering, water is most important at the budding stage.

Water may be applied in furrows, by flooding, or by use of overhead sprinklers. The use of sprinklers may result in disease development, particularly after safflower reaches the bud stage.

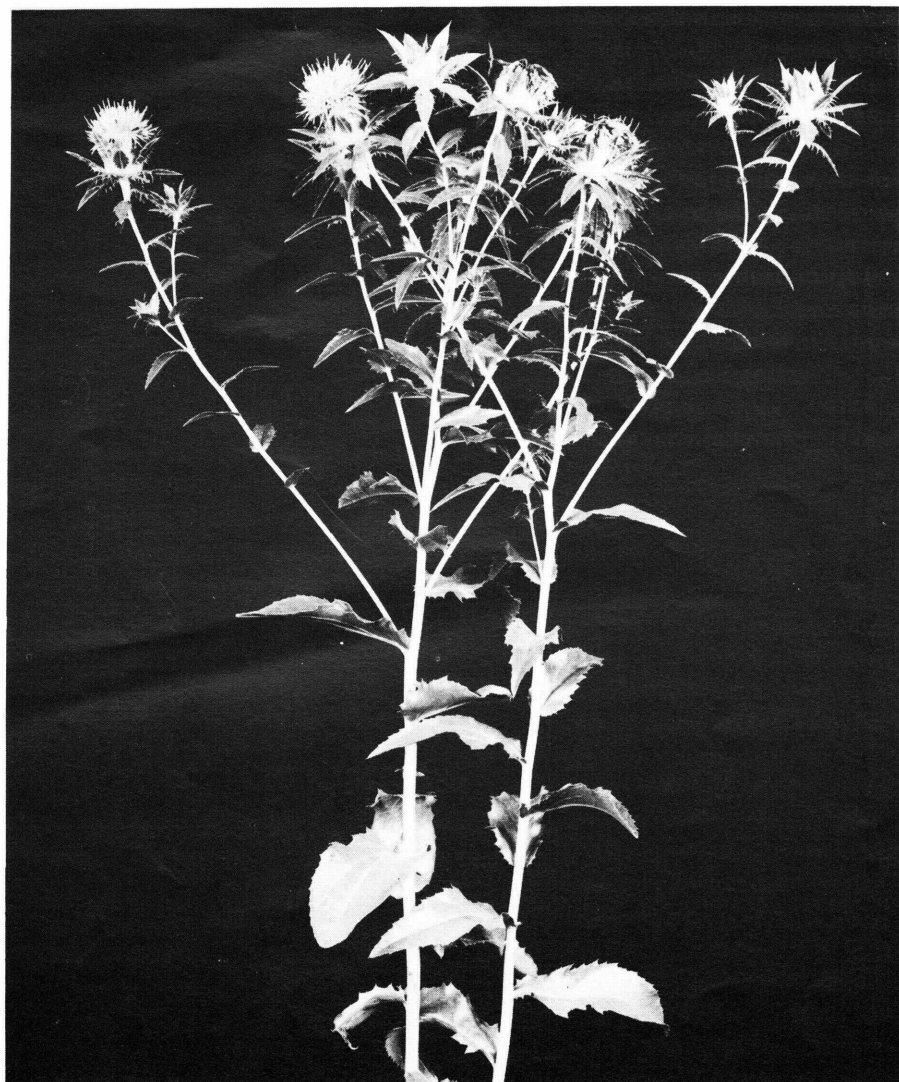
Do not irrigate from the time plants emerge until stems develop because irrigation during this period will benefit weeds, which compete with safflower. Avoid either underirrigation or overirrigation. Underirrigation makes plants more susceptible to root rot during and following subsequent irrigations. Overirrigation should be avoided because safflower plants may die if water stands in a field for more than a few hours.

HARVESTING

Spring-planted safflower matures in about 120 days under favorable conditions. Cool weather or rain may delay maturity.

After safflower matures, it does not lodge and its seeds do not shatter easily; it may be harvested by direct combining. Combines with either tooth or bar cylinders may be used.

Safflower is ready for harvest when the plant has thoroughly



BN-6695

Safflower plant showing leaves, branching habit, and flower heads.

dried. Test for maturity by squeezing several of the most recently developed heads. If the seed separates easily, it can be threshed. Green or wet seed is hard to thresh and will not store well if it has more than 8 percent of moisture.

The crop can be combined as soon as it is mature. It may be left in

the field for as long as 30 days with little loss at harvest. Light rains or frost after maturity will not harm it greatly.

If seed will be used for planting, harvest safflower as soon as it is mature.

Safflower may be swathed and allowed to dry before it is threshed

with a combine and pickup attachment. This is recommended when green weeds are a problem.

Safflower cannot be threshed as fast as barley or wheat. Reduce speed of the combine to 500-800 r.p.m. so few seeds are cracked in threshing. Concave teeth should just begin to mesh with cylinder teeth. Adjust rub- or bar-type cylinders to $\frac{1}{2}$ -inch clearance between concaves and cylinder or sufficiently close to thresh all the seed without damage.

Safflower may shatter if the reel slats strike ripe seed heads directly. Modify the reel by attaching 4- to 6-inch strips of flexible belting to the slats. Raise the reel so that only the top of the belting hits the plants. Equalize speed of reel with forward speed of the combine. If heads catch on slats, plug the space between the reel arms with plywood, canvas, or mesh wire screen; or, remove the reel.

Set shaker screens slightly faster than for small grain. Adjust wind speed to remove the light seed but not the filled seed. Enough wind is needed to blow away the chaff from the seed. Screen the front of the radiator on the combine motor to prevent this chaff from clogging the radiator.

Lodged plants can be combined by using a pickup guard.

Handle threshed safflower seed in bulk, if possible, because seed sacks pick up spines from the fields.

INSECTS

Insects have caused only minor damage to the total safflower crop.

However, they may cause substantial loss in individual fields.

For current recommendations on controlling insects that attack safflower, ask your county agricultural agent or write to your State agricultural experiment station or to the U.S. Department of Agriculture, Washington, D.C., 20250.

Damage by lygus bugs can cause safflower heads to discolor, develop rot, or fail to form. Damage is most severe in late-sown fields.

Wireworms may cause poor stands. Control these insects when necessary by treating seed with a recommended insecticide before planting.

Aphids, leafhoppers, flower thrips, and larvae of the sunflower moth cause occasional damage to safflower.

Grasshoppers may feed on safflower after small grains are harvested. Damage usually is limited to margins of fields.

A stem borer has been reported attacking safflower in California and other safflower-producing areas. Damage to an individual plant is severe. No large populations of borers have been reported as of 1965.

DISEASES

In the United States, the most prevalent diseases of safflower are rust,² root rot,³ leaf spot,⁴ bud rot,⁵ and Verticillium wilt.⁶ The amount of damage they cause depends on weather conditions, cul-

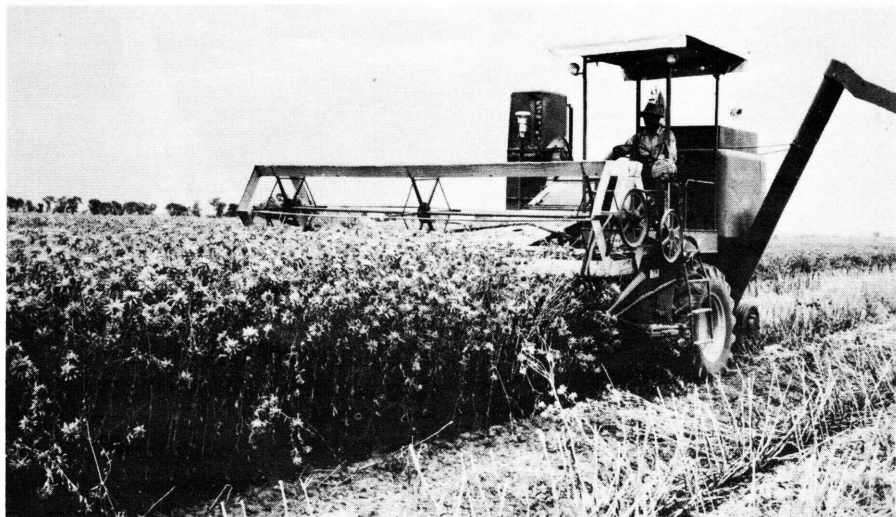
² *Puccinia carthami*.

³ *Phytophthora drechsleri*.

⁴ *Alternaria carthami*.

⁵ *Alternaria* or *Botrytis* spp.

⁶ *Verticillium albo-atrum*.



BN-6696-X

Harvesting safflower with a combine.

tural practices, and the safflower variety.

Under certain conditions, diseases make production of present safflower varieties unprofitable.

Rust

Rust may occur in any area in the United States where safflower is adapted. High humidity from atmospheric conditions or irrigation is necessary for rust to develop profusely. The disease seldom is a problem on dry land.

Rust may cause serious stand loss when it develops on the seedling hypocotyl from either seed- or soil-borne spores. In older plants, rust may attack the leaves; and, if severe, may cause loss in yield.

Seed treatment with certain volatile mercury fungicides will give good control of seedborne spores.

Crop rotation and the use of treated or rust-free seed are recommended. In some areas late-planted fields usually are less affected than early-planted fields.

No rust-resistant varieties were available in 1966. Rust-resistant lines are being tested and may become available.

Root Rot

The soil-borne fungus that causes root rot is widely distributed in the western United States. Root rot is most severe on surface-irrigated land; it seldom affects subirrigated or dryland plantings.

Although it may occur at any time, root rot usually develops after the first irrigation. Affected plants dry up quickly and turn light green. Roots and lower stems rot and become dark green or black.

Do not surface irrigate safflower on land with poor water penetration or drainage. Avoid long irrigation runs. Irrigate often enough to prevent firing of lower leaves from lack of water.

Where possible, grow safflower on beds under furrow irrigation instead of flood irrigation. Furrow irrigation reduces damage by root rot.

Varieties differ in resistance to root rot.

Leaf Spot

Leaf spot reduces yield and oil content of safflower. It may occur whenever and wherever frequent dews and showers fall during the middle and latter part of the growing season.

Leaf-spot fungus may be seed-borne. The disease produces large, brown, irregular spots on leaves and flower bracts. It discolors seed and causes seed rot and damping-off.

Seed treatment with a volatile mercury fungicide will give excellent control of the seed rot and damping-off phases of the disease. Available safflower varieties have some tolerance to leaf spot. This disease is one factor which limits production to areas having dry atmospheric conditions.

Bud Rot

Bud rot may affect most of the heads in a field and reduce yields. It is a problem in areas with high humidity or frequent rainfall. Bud rot occurs in the northern Great Plains and in the foggy coastal areas of California.

But rot often is associated with insect injury to the buds. Fungi invade injured buds, causing them to discolor, shrivel, or fail to develop.

Verticillium Wilt

Verticillium wilt has caused minor damage in the present areas of production. This disease may attack irrigated safflower in areas where it attacks other crops.

No resistant varieties are available at present.

Precautions

Pesticides used improperly can be injurious to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them.

When handling a pesticide, wear clean, dry clothing.

Avoid repeated or prolonged contact of pesticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of pesticide dusts or mists.

Avoid spilling pesticide concentrate on your skin, and keep it out of your eyes, nose, and mouth. If you spill any on your skin, wash it off immediately with soap and water. If you spill it on your clothing, launder the clothing before wearing it again.

After handling a pesticide, do not eat, drink, or smoke until you have washed your hands and face. Wash your hands and face and any other exposed skin immediately after applying pesticide.

To protect water resources, fish, and wildlife, do not contaminate lakes, streams, or ponds with pesticide. Do not clean spraying equipment or dump excess spray material near such water.

Do not apply pesticides to plants during hours when honey bees and

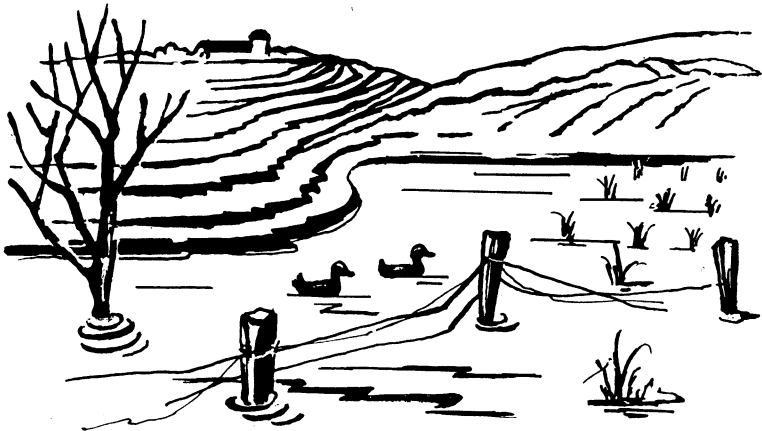
other pollinating insects are visiting them.

Avoid drift of pesticide to nearby wildlife habitats, bee yards, crops, or livestock.

Dispose of empty pesticide containers at a sanitary land-fill dump, or bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies. If you have trash-collection service, wrap small containers in heavy layers of newspapers and place them in the trash can.



Use Pesticides Safely
FOLLOW THE LABEL
U.S. DEPARTMENT OF AGRICULTURE



Conserve your soil and water

Develop a farm or ranch conservation plan.

Use each acre within its capability.

Contour, strip crop, or terrace sloping land.

Plant and manage trees as a crop.

Improve range; manage grazing.

Encourage wildlife as useful and profitable crops.

Plant grass on idle land.

Use ponds to impound water.

Improve irrigation or drainage systems.

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